Nanocomposite material based on CdSe and reduced grapheme oxide for photoelectrochemical systems

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CdSe halide based compounds, which have a high light absorption coefficient in the visible region, promise much as semiconducting materials for photoelectrochemical solar energy converters.

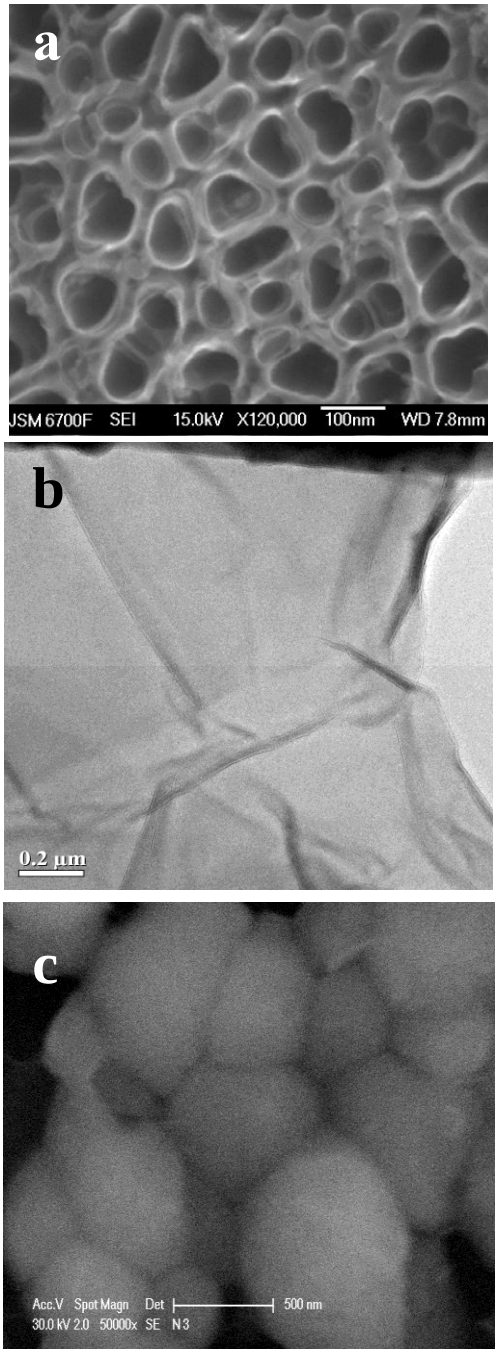

Fig 1. Electron micrograph: (a) of TiO_2 nanotubes, (b) reduced graphene oxide, (c) CdSe/RGO semiconductor film deposited on TiO_2 nanotubes after annealing at T = 530°C.

We have investigated the photoelectrochemical properties of CdSe/reduced graphene oxide nanocomposite films deposited on a Ti substrate with a specially formed layer of TiO_2 nanotubes, which have promise in photoelectrochemical systems.

The TiO_2 nanotubes (NT-TiO_2) (Fig 1(a)) have been obtained by the method of potentiostatic anodic polarization of a titanium foil in a sulfuric acid solution containing F^- ions [1]. This method for the preparation of titanium substrate ensures a good adhesion to the CdSe layer in the case of its application and annealing. The cathode dark current magnitude, measured at the photoelectrodes obtained in a polysulfide electrolyte, was not over $5 \cdot 10^{-6}$ A/cm^2 at the potentials corresponding to photopotential at the working point of photoelectrochemical converter.

Reduced graphene oxide (RGO) (Fig 1(b)) was prepared by the oxidative destruction of multiwalled carbon nanotubes by the modified Hummers method, followed by reduction [2]. The structural peculiarities of graphene sheet give rise to unique electrophysical characteristics and other unusual properties.

The NT-TiO_2/CdSe/RGO nanocomposite films have been obtained by mechanical application of an aqueous suspension of fine CdSe, $CdCl_2$ powders with addition of RGO and polyethylene glycol to a conducting Ti substrate with a formed layer of TiO_2 nanotubes (Fig 1(c)). The semiconductor compounds obtained are stable in the redox system S^{2-}/S_2^{2-}, which is used as the working electrolyte of photoanode.

It has been found that the modification of semiconductor electrode with RGO results in an improvement of the load characteristics of the photoelectrochemical cell, as a result of which the electrode photopotential at the point of maximum power output increases. It has been found that this treatment of photoelectrodes leads to a decrease in the density of recombination centers formed by surface defects, which are in the three-phase contact zone and to an increase in the characteristic relaxation time of photopotential and in its amplitude, i.e. to an increase in electrode photosensitivity. The photoanodes under investigation have been tested in a photoelectrochemical cell with hydrogen accumulation, developed by us [3]. The efficiency of the conversion of solar energy to bound-hydrogen energy $\delta \approx 4 \div 5$ %.

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3. *Rusetskii I.A., Slobodyanyuk I.A., Kolbasov G.Ya. et al.* Photoelectrochemical system for hydrogen production and accumulation by action of sunlight // Voprosy Khimii I Khimicheskoi Tekhnologii. -2011. -**4**(2), P. 155-157.